later stages of extraseminal life of corn plant.

(*b*) *Bunt of Wheat.*—Seedling infection. Infection is specialized to stem top meristem. It occurs only in earliest stages of extraseminal life of host plant.

(*c*) *Loose Smuts of Wheat and Barley.*—Floral or intraseminal infection. Infection also specialized to the stem, the growing point of the meristem. It occurs in an early stage of intraseminal life of host plant.

(*a*) *Fungus of Lolium temulentum.*—Method and occurrence of infection as in type (*c*), but spore formation probably abandoned and the beginnings of a symbiosis possibly established.

Many problems relating to the details of type (*c*) are yet unsolved, as for instance, the behavior of spores in regard to stigmas, and the results of different periods of infection.

The second paper on the program was by Professor Bruce Fink: "Present Problems in American Lichenology." Professor Fink called attention to the lack of workers in the field of American lichenology, caused in all probability by the fact that the subject has little economic significance. The literature on this branch is unarranged and even uncollected, and the speaker is now engaged in studying the literature bearing on the subject. Up to the present time he has collected about 500 titles. The structure of the lichens interferes with the ordinary technique of sectioning and staining, but these difficulties are not more serious than those met with in the study of fungi, which have been for the most part overcome. There is great confusion in the nomenclature and classification of lichens; and no agreement has been reached as to the limits of genera and the way in which types can be fixed. Lichens are the first vegetation appearing on unoccupied land, and are of fundamental importance ecologically. Their relation to soil and subsequent vegetation has, however, been little studied. The old problem of the relation of the symbionts in the lichens, whether mutually beneficial or antagonistic, is still unsolved. With the exception of the area about New Bedford, Massachusetts, very few localities have been carefully studied in relation to their lichen flora. Professor Fink has himself listed some 500 species from Minnesota. He concluded his paper with a plea for greater popularization of the study of lichenology.

This ended the evening's program. At the luncheon which was served Dr. Freeman addressed the society informally, taking leave of his associates on the eve of his departure for his new post at the University of Minnesota.

W. E. SAFFORD,
Corresponding Secretary

DISCUSSION AND CORRESPONDENCE

INHERITANCE OF FLUCTUATING VARIATIONS

TO THE EDITOR OF SCIENCE: In the issue of SCIENCE for January 31 Professor Bigelow asks Dr. Ortmann how he would account for correlation between parents and offspring in cases of fluctuating variations, if variations of this type are not transmitted. I do not wish to answer this question for Dr. Ortmann, but I do wish to call attention to some confusion in the use of the term "fluctuating variation." It is necessary for us to agree on its meaning in order to avoid misunderstandings. Let us consider for a moment the different types of variation and decide on which of them may properly be included under the term "fluctuating variations." In the first place, there are some variations which I think we will all agree are not included. Two of these relate to real evolutionary changes. First, organisms in their phylogenetic development acquire new characters. We may mention the horns of cattle as an example. The development of hair or feathers as an external covering is another example. Even these characters may be looked upon as, in a sense, modifications of previously existing ones. Second, a character already present may undergo permanent change. In this way we get the various shapes of leaves, say of the genus *Quercus*. We may also include here the loss of certain characters which were formerly possessed. For instance, red swine have lost the power of producing black pigment. It is conceivable that very little of the variation we find in a generation of individuals from

the same parents is due to any of the causes mentioned above.

But variation as between individuals of the same generation may be, to some extent, due to what has been aptly termed "place effect." This is especially true when a species is transported to new environment, a good deal of variation occurring which seems to be due to change in environment, such variation may partake partially of the nature of fluctuating variation, but this is a special case which we do not need to consider here.

This leaves two distinct types of variation due to wholly different causes which have hitherto been more or less confused. By some writers they have both been included under "fluctuating variations." The first of them is well exemplified in a field of corn, where ordinarily hardly any two individuals are alike. It is fully demonstrated by the work of Nilsson, in Europe, and Shull, in this country, which will be referred to below, that by far the greater part of the variation of our corn field is due to the fact that we have in the various individuals almost countless combinations of Mendelian characters and that these combinations change with each new generation. The same thing is true on a smaller scale with all species that cross-fertilize under any conditions, and even with close fertilization this condition exists to a greater or less degree. If we require a corn plant to close fertilize, by this process we permit the formation of a few individuals which are perfectly homozygote; *i. e.,* the inheritance of the individual from the two parents becomes exactly alike. Then if we take the pains to seek out these homozygotes and propagate them, allowing no cross-fertilization, we completely eliminate the type of variation here referred to and get forms that vary only in response to the immediate environment. Variation due to this re-combination of characters with each generation would naturally show correlation between parent and offspring, but when we have eliminated this type of variation such correlation would no longer exist.

Species that never cross-fertilize or that do so very rarely, and plants that are not allowed to do so, have been shown by careful study by Nilsson, Shull, Hopkins and others to consist of mixtures of strains which when separated show no variation except that due to environment, or rather the larger part of the species exhibits this condition, for even in such species there may be a small admixture of heterozygotes.

Nilsson in Europe and Shull in this country have obtained these perfectly homozygote individuals, Nilsson working with wheat and many other species, and Shull with corn. The individuals of a generation are as much alike as identical twins. These are the so-called elementary species, this term being applied through a misconception of their nature. (This subject will be fully discussed in another place.)

Finally we have variation due to the immediate environment of the individual. For instance, a variation in food supply may cause two individuals having identically the same inheritance to differ in size and in other characteristics.

Dr. Shull confines the term "fluctuating variations" wholly to variations of the last-mentioned type. He rigidly excludes variations due to the heterozygote nature of the parents. I fully agree with him in this use of the term. When we so limit it, we may then say that fluctuating variations are not transmitted.

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SPECIAL ARTICLES

THE DERIVATION OF FECHNER'S LAW

ABOUT eighty years ago E. H. Weber observed that the least perceptible increment to a stimulus affecting several of the sense organs, under fixed subjective conditions of attention, expectation and fatigue, bore a definite relation to the amount of that stimulus.

G. T. Fechner, thirty years later, extended Weber's observations and formulated his results in mathematical terms. Calling the stimulus L and the least perceptible increment δL, then Fechner's statement of what he termed Weber's Law is that $\delta L/L =$ constant.